the laws of culture, and by these laws learn to construct a better future. Thus we study the philosophy of the past, not that we may adopt that philosophy, but that we learn the laws of progress and avoid the errors of the past and construct a wiser future.

In the history of philosophy two lessons are plainly taught. The first is that no man can evolve an enduring philosophy from his own thought, but that philosophy must be evolved from facts, for the wrecks of such philosophies are scattered over the pages of thought from the time of Plato to the time of Hegel. The second great lesson is this, that the construction of an enduring philosophy is not the work of one mind, but of a multitude of men who gather their materials by scientific research. Since the days of Aristotle the wrecks of such attempts have strewn the highway of history. Even Descartes failed to do more than to make a contribution, while Newton and Darwin gave us but materials for philosophy, not philosophy itself. A host of men have engaged in this work collecting and organizing materials, and another host yet to live must carry on the work ere a scientific philosophy is developed, while the structures which have hitherto been developed mark but the stages of growth and those philosophies which have been wrought of pure thought; thought not informed by fact, are great lighthouses of warning to guide us from the rocks. It is thus as a philosopher of the scientific school that Dana's name will be remembered and Dana's contributions forever remain.

In a quiet street of the good old town of New Haven, Dana labored far from the turbulent crowd, absorbed in facts of observation and acquisition, loving and loved as only the quiet student can love and be loved. No pageantry marked his life, no glittering honors shed their luster over his career; he built only as the philosopher builds and he lived only as the philosopher lives.

The thoughts of early man are now unknown;
In all the tomes of world no page is his.
The grand phenomena of arching heaven,
The wondrous scenes of widespread earth and sea,
The pleasure sweet and bitter pain of life,
As these are known to-day so were they then,
But all in psychic terms of simple men.

And yet his thoughts live on to later time.
As mind has grown the thoughts have been enlarged,
Revolving oft in human soul through life,
In grand endeavor yet to reach the truth,
Repeated o'er by streams of countless men,
And changing e'er with mind's expanding view,
Till errors old have grown to science new.

With knowledge gained man never is content:
Nor wold, nor mount, nor gorge, nor icy field,
Nor depths of sea, nor heights of starry sky,
Can daunt his courage in this high emprise,
Or sate the vision of his longing eyes.

J. W. POWELL.

PASTEUR.

LADIES AND GENTLEMEN: I am to speak to you of the life and achievements of one who has won imperishable renown by his valuable contributions to human knowledge, and who has recently been buried in the city in which his scientific labors have been prosecuted, with all the honors which it was possible for a grateful people to confer. It is certainly a happy augury for the future when the man of science, whose achievements have been the result of painstaking and laborious work in the laboratory, receives the grateful plaudits of his fellowmen during his life time and the honors which were formerly only paid to civil potentates or military heroes when his body is committed to the tomb. It has been the fortune of few men to contribute so largely to the sum of useful knowledge, and fewer still have lived to receive such ample recognition of the value of their scientific work.

Pasteur's success has been due to a combination of personal qualities which especially fitted him for the pioneer work which

he has done in his chosen field of scientific investigation. With that penetrating intellect and versatility of resource which constitutes genius was combined an energy and persistence of purpose, a disregard of accepted theories not supported by evidence, and an appreciation of the value of the experimental method as the only reliable means of arriving at exact truth. No amount of conservative opposition intimidated him when he announced results obtained by his carefully conducted laboratory experiments, and no false pride seduced him into maintaining a position which he had once taken, if the experimental evidence was against him. This rarely happened. But where is the man of science who is infallible? Working in a new field by methods largely of his own devising, which were necessarily more or less imperfect at the outset, it is surpising how few mistakes he made.

With his genius for scientific research, his indomitable perseverance and the forceful character which enabled him to defend his discoveries so successfully, there must have been associated a kindly disposition; for those who were closely associated with him in his laboratory work were devotedly attached to him. He evidently had the faculty of inspiring others with his enthusiasm for science, and their loyalty to him and to their common mistress was rewarded by the frank acknowledgement on his part of their share in the work accomplished. So far as I am aware, he never showed any disposition to appropriate for himself credit due to another, whether that other was an associate or pupil in his own laboratory or one who was prosecuting his investigations elsewhere. The speaker's personal acquaintance with Pasteur is limited to a memorable half day spent in his laboratory about ten years ago. Although still disabled to some extent by paralysis, resulting from his first apoplectic attack, he conducted me through his laboratory, and with the greatest kindness explained to me the methods in use and the results recently accomplished in the lines of experimental work which at that time occupied the attention of himself and his colleagues.

The time at my disposal will permit only a brief review of the life and work of this illustrious savant; but this review will show that his scientific achievements are of the highest order, and that the practical benefits resulting from his labors have extended to all parts of the civilized world. He belongs not alone to France, but to science, and it is eminently fitting that we should pay a tribute to his memory in this capital city of a country in which his name is so well known and in which the results of his scientific investigations are so highly appreciated.

Louis Pasteur was born at Dôle, a small town in the Department of Jura, France, on the 27th of December, 1822; he died at his home in Garches, a suburb of Paris, on the 28th of September of the past year.

Pasteur's father had been a soldier in the army of Napoleon, but at the time of his famous son's birth was working at his trade as a tanner. In 1825 the family moved to Arbois, a small town in the same department, and here Louis Pasteur attended school at the *collège communal*. Later he was sent to the college at Besançon, where he took his degree of the *Bachelier des Lettres*. He subsequently entered the École Normale of Paris, and while there devoted himto his favorite study—chemistry. Three years after joining the École Normale he was appointed Assistant Professor of Physical Science. In 1848 he was appointed Professor of Physics at Dijon, and after a few months resigned this position for the chair of chemistry in the University of Strassburg. In 1854 Pasteur was induced to accept the position of Dean of the newly created Faculty of Sciences at Lille; and in

1857 he returned to Paris as scientific director of the École Normale, where he had gained his first scientific laurels. In 1862 Pasteur became a member of the Institute and in the same year he was appointed Professor of Geology, Physics and Chemistry in the *École des Beaux Arts*. He was elected to the Academy of Sciences, taking the *fauteuil* of Littré in 1881. The same year he received the Grand Cross of the Legion of Honor. In 1874 the National Assembly of France voted him a life pension of 20,000 francs annually. Upon the anniversary of his 70th birthday, December 27, 1892, he received from his compatriots a superb ovation at the Sorbonne, which was attended by President Carnot, the members of the French Institute, all foreign ministers and ambassadors then at the French capital, and delegates from scientific societies in all parts of the world. The Pasteur Institute, established in his honor, was inaugurated with proper ceremonies on the 14th of November, 1888. It is situated in the *rue Dutot*, Paris, and is an imposing stone building in the style of Louis XIII. It was built and equipped from a fund raised by public subscription amounting to 2,586,000 francs. Of this sum 200,000 francs was voted by the French *Chambres Legislatif*. After the completion and equipment of the building more than 1,000,000 francs remained as a permanent endowment.

The time at my disposal will permit of but a brief review of Pasteur's scientific achivements. After having made some notable discoveries in chemistry his attention was attracted to the minute organisms found in fermenting liquids, and by a brilliant series of experiments he demonstrated the fact that the chemical changes attending fermentation are due to the microscopic plants known as bacteria; also that different species give rise to different kinds of fermentation, as shown by the different products evolved during the process. In prosecuting these studies he discovered the species which produce lactic acid, acetic acid and butyric acid, and he added largely to our knowledge relating to alcoholic fermentation and the class of microörganisms to which it is due. He showed that in the absence of living organisms no putrefaction or fermentation can occur in organic liquids, and that these low organisms do not develop by spontaneous generation, as was at that time generally believed, but have their origin from preëxisting cells of the same species, which are widely distributed in the atmosphere, especially near the surface of the earth. Various experimenters had shown that a development of bacteria sometimes occurs in boiled organic liquids excluded from the air. Pasteur showed that this was not due to spontaneous generation, but to the survival of the spores of certain species of bacteria; these are able to resist a boiling temperature without loss of vitality and reproductive power.

In 1865 the distinguished French chemist, Dumas, invited his former pupil, Pasteur, to make investigations with reference to the cause and prevention of a fatal malady among silkworms, which threatened to destroy the silk industry of France. In the course of an investigation which occupied several years, Pasteur succeeded in demonstrating the nature of the infectious malady known as *pébrine*, the mode of its transmission, and the measures necessary to eradicate it. Following his advice the growers of silkworms succeeded in banishing the scourge, and within a few years the industry was reëstablished upon its former profitable footing.

This pioneer work led to further investigations with reference to the cause and prevention of certain infectious diseases of the lower animals, and especially to the fatal disease of cattle and sheep known as anthrax. Having satisfied himself that this disease is due to a bacillus, which is found

in great numbers in the blood of infected animals, he demonstrated by experiment that this bacillus rapidly loses its virulence when cultivated in artificial media at a temperature of 42° to 43° C.; also that animals inoculated with this 'attenuated' virus suffer a mild attack of the disease, and that after their recovery they are immune against future attacks, even when inoculated with the most virulent material. This discovery has been applied practically, on an extensive scale, in France, Austria, Switzerland and other European countries. The result of anthrax inoculations made by Pasteur's method in France during the past twelve years was summarized by Chamberland in 1894. He reports the total number of animals inoculated during this period as 1,788,677 sheep and 200,962 cattle; and estimates the total saving as the result of the inoculations as 5,000,000 francs for sheep and 2,000,000 francs for cattle.

Another infectious disease in which Pasteur's method has been employed with success is *rouget*, or hog erysipelas. Chamberland states that, as a result of the protective inoculations practiced with Pasteur's 'vaccines,' the mortality from this disease in France has been reduced from about 20% to 1.45%. Hutyra reports that during a single year (1889) 48,637 pigs were inoculated with Pasteur's vaccines in Hungary with a loss of 0.29%, while the losses upon the same farms in previous years averaged from 10 to 30%.

But we must pass to that portion of Pasteur's scientific work which has most engaged the attention of the public. Pasteur first announced his success in reproducing hydrophobia in susceptible animals by inoculations of material obtained from the central nervous system, in a communication made to the Academy of Sciences on May 30, 1880. Continuing his investigations, he reported, in 1884, his success in conferring immunity against hydrophobia in 19 dogs inoculated, in the presence of a commission appointed for the purpose, as a test experiment. These animals had been rendered refractory by his method. The 19 protected animals and 19 control animals, obtained from the public pound without any selection, were tested at the same time. The test was made upon some of the animals of both series by inoculation with virulent material upon the surface of the brain, and upon others by allowing them to be bitten by rabid dogs, and upon still others by intravenous inoculations. Not one of the protected animals developed hydrophobia; on the other hand, three of the control animals out of six bitten by a mad dog developed the disease, five out of seven which received intravenous inoculations died of rabies, and five which were trephined and inoculated on the surface of the brain died of the same disease.

With reference to his first inoculations in man, Pasteur says:

"Making use of this method, I had already made fifty dogs of various races and ages immune to rabies, and had not met with a single failure, when, on the 6th of July, quite unexpectedly, three persons, residents of Alsace, presented themselves at my laboratory."

These persons were Theodore Vone, who had been bitten on the arm on July 4th; Joseph Meister, aged nine, bitten on the same day by the same rabid dog; and the mother of Meister, who had not been bitten. The child had been thrown down by the dog and bitten upon the hand, the legs and the thighs, in all in fourteen different places. Pasteur commenced the treatment at once, and had the satisfaction of reporting to the Academy of Sciences in March of the following year (1886) that the boy remained in perfect health. Since this time Pasteur Institutes for the treatment of hydrophobia have been established in all parts of the civilized world, and the statis-

tical reports published justify the belief that when the treatment is instituted at an early date after the bite, and is properly carried out, its protective value is almost absolute. At the Pasteur Institute in Paris 9,433 persons were treated during the years 1886 to 1890, inclusive. The total mortality from hydrophobia among those treated was considerably less than one per cent. (0.61). In 1890 416 persons were treated who had been bitten by animals proved to be rabid, and among these there was not a single death. In 1891 the number of inoculations was 1,539, with a mortality of 0.25%; in 1892, 1,790 with a mortality of 0.22%; in 1893, 1,648 with a mortality of 0.36%; in 1894, 1,387 with a mortality of 0.50%.

There has been and is still a considerable amount of scepticism among members of the medical profession, and others, as to the practical value of Pasteur's inoculations for the prevention of hydrophobia; and some physicians have even contended that the disease known by this name is not the result of infection from the bite of a rabid animal, but is a nervous affection due to fear. The time at my disposal will not permit me to present for your consideration the experimental and clinical evidence upon which I base the assertion that nothing in the domain of science is more thoroughly demonstrated than the fact that there is a specific infectious disease known to us as rabies, or hydrophobia, which may be communicated to man, or from one animal to another, by the bite of a rabid animal; and that Pasteur's inoculations prevent the development of the disease in animals which have been infected by the bite of a rabid animal or by inoculations with infectious material from the central nervous system. This being the case, it is evident that there is a scientific basis for Pasteur's method of prophylaxis as applied to man, and his published statistics give ample evidence of the success of the method as carried out at the Pasteur Institute in Paris and elsewhere. Great as have been the practical results which have already followed Pasteur's brilliant discoveries, there is reason to believe that in the future still more will be accomplished, especially in combatting the infectious diseases of man. Having pointed out the way, a multitude of earnest investigators in various parts of the world are now engaged in laboratory researches relating to the cause, prevention and cure of infectious diseases. Already, in the treatment of diphtheria and of tetanus with blood serum obtained from immune animals, results have been obtained of the highest importance, and it seems probable that in the near future other infectious diseases will be cured by a specific treatment based upon scientific information obtained by those who have been following in the pathway marked out by Pasteur, the illustrious pioneer in this line of research.

GEO. M. STERNBERG.

HELMHOLTZ.

HERMANN LUDWIG FERDINAND, BARON VON HELMHOLTZ, was born at Potsdam on August 31, 1821.

In 1842 he received his decree in medicine at Berlin, and entered the government service as an army surgeon.

In 1847 he published his essay on the Conservation of Energy.

In 1849 he was appointed professor of physiology at Bonn.

In 1851 he invented the Ophthalmoscope.

In 1855 he was made professor of anatomy and physiology at Bonn.

In 1859 he was appointed to the same chair at Heidelberg.

In 1860 he was made one of the foreign members of the Royal Society of London.

In 1863 he published his great work on the 'Sensations of Tone.'

In 1866 the first edition of his 'Physiological Optics' was completed.